

EXHIBIT 1

Professor Jerry A. Hausman

July 2018

EDUCATION:

OXFORD UNIVERSITY
D. Phil. 1973 (Ph.D), B. Phil. 1972

BROWN UNIVERSITY
A.B. (Summa Cum Laude), 1968

THESIS: "A Theoretical and Empirical Study of Vintage Investment and Production in Great Britain,"
Oxford University, 1973.

FELLOWSHIPS, HONORS AND AWARDS:

Phi Beta Kappa
Marshall Scholar at Oxford, 1970-1972
Scholarship at Nuffield College, Oxford, 1971-1972
Fellow, Econometric Society, 1979
Frisch Medal of the Econometric Society, 1980
Fisher-Schultz Lecture for the Econometric Society, 1982
John Bates Clark Award of the American Economic Association, 1985
Smith Lectures, Brigham Young University 1986
Jacob Marschak Lecture for the Econometric Society, 1988
Hooker Lectures, Macmaster University 1989
Fellow, National Academy of Social Insurance, 1990
American Academy of Arts and Sciences, 1991
Fellow, Journal of Econometrics, 1998
Shann Memorial Lecture for the Australian Economics Society, 2003
Cenmap International Fellow, University College London, 2004
Honorary Professor, Xiamen University, 2005
Biennial Medal of the Modeling and Simulation Society of Australia and New Zealand, 2005
Fellow, Modeling and Simulation Society of Australia and New Zealand, 2005
Condliffe Memorial Lecture, University of Canterbury, NZ, 2005
Keynote Lecture, Far East Meetings of Econometric Society, Beijing 2006
Keynote Speaker, ACCC Conference, Australia, 2006
Keynote Speaker, Panel Data Conference, Xiamen China, 2007
Keynote Speaker, FTC/Northwestern Antitrust Conference, 2008
Honorary Fellow, Nuffield College, Oxford University, 2008
Journal of Applied Econometrics Lectures, 2009
Leigh Lecture, Washington State University, 2009
MIT UEA Teaching Award, 2009
Journal of Financial Economics "All Star Paper", 2009
Honorary Advisory Board, Chang Mai University, Thailand, 2009-
Honorary Degree, Chang Mai University, Thailand 2010
Keynote Speaker, UC Berkeley Conference on Mobile Telecommunications, 2010
Keynote Speaker, Xiamen University (China) conference on 30 Years of Specification Tests, 2010
Tinbergen Lectures, Tinbergen Institute, Netherlands, 2011
Keynote Speaker, Econometrics Conference, Cambridge Univ., UK, 2011
HOH Lectures, Humboldt Univ. Berlin, 2011
Gorman Lectures, University College London, 2011
Conference on the Hausman Specification Test, Louisiana State Univ., 2012
Keynote Speaker, 18th Panel Data Conference, Paris, 2012
American Economic Association Distinguished Fellow 2013

Keynote Speaker, Cambridge University Conference on Panel Data, 2013
 Conference in Honor of Jerry Hausman, Curtin University, Fremantle, Australia, 2013
 Keynote Speaker, Africa-Asia-Australia Telecommunications Conference, Perth, Australia, 2013
 Keynote Speaker, Conference on TOU Prices, Nenching China, 2013
 Conference in Honor of Jerry Hausman, Xiamen University China, 2014
 Keynote Speaker, Conference in Honor of Jerry Hausman, Xiamen University China, 2014
 Keynote Speaker, 22nd Panel Data conference, Fremantle, Australia, 2016
 Bateman Lecture, University of Western Australia, 2016
 Keynote Lecture, Universidad Nacional de Colombia, Bogota, 2016
 Distinguished Speaker Series, UCLA, 2017
 G. Chow lecture, Xiamen University, China 2017
 British Academy, Corresponding Member, 2018

EMPLOYMENT:

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

2016- John and Jennie S. MacDonald Professor, Post-tenure
 1992-2016 John and Jennie S. MacDonald Professor
 1979- Professor, Department of Economics
 1976-79 Associate Professor, Department of Economics
 1973-76 Assistant Professor, Department of Economics
 1972-73 Visiting Scholar, Department of Economics

VISITING APPOINTMENTS:

2016- Distinguished Visiting Professor of Economics, UCLA
 1986-87 Visiting Professor, Harvard Business School
 1982-83 Visiting Professor, Harvard University Department of Economics
 Visiting Positions: University of Washington, Australian National University, Ecole Normale Supérieure, Oxford University, University of Sydney, Wuhan University, Beijing University, University of Western Australia, University College London, Uppsala University, Xiamen University, Sorbonne

U.S. ARMY, ANCHORAGE, ALASKA

1968-70 Corps of Engineers

PROFESSIONAL ACTIVITIES:

Associate Editor, Bell Journal of Economics, 1974-1983
 Associate Editor, Rand Journal of Economics, 1984-1988
 Associate Editor, Econometrica, 1978-1987
 Reviewer, Mathematical Reviews, 1978-1980
 American Editor, Review of Economic Studies, 1979-82
 Associate Editor, Journal of Public Economics, 1982-1998
 Associate Editor, Journal of Applied Econometrics, 1985-1993, 2009-
 Advisory Editor, Economics Research Network and Social Science Research , 1998-
 Advisory Editor, Journal of Sports Economics, 1999-
 Advisory Editor, Journal of Competition Law & Economics, 2004-
 Advisory Editor, Journal of Applied Economics, 2005-
 Member of MIT Center for Energy and Environmental Policy Research, 1973-1995
 Research Associate, National Bureau of Economic Research, 1979-
 Member, American Statistical Association Committee on Energy Statistics, 1981-1984
 Special Witness (Master) for the Honorable John R. Bartels, U.S. District Court for the Eastern District of New York in Carter vs. Newsday, Inc., 1981-82
 Member of Governor's Advisory Council (Massachusetts) for Revenue and Taxation, 1984-1992

Advisor US Social Security Commission 1982-1983
 Member, Committee on National Statistics, 1985-1990
 Member, National Academy of Social Insurance, 1990-
 Member, Committee to Revise U.S. Trade Statistics 1990-1992
 Director, MIT Telecommunications Economics Research Program, 1988-
 Board of Directors, Theseus Institute, France, 1988-1995
 Member, Conference on Income and Wealth, National Bureau of Economic Research, 1992-
 Member, Committee on the Future of Boston, 1998
 Member, GAO Expert Panel to Advise USDA on Econometric Models of Cattle Prices, 2001-2
 Advisor, China Ministry of Information on Telecommunications Regulation, 2002-2006
 Member, FTC Panel on Merger Evaluation, 2005
 Advisor, New Zealand Commerce Commission 2010
 Member, Panel Data Conference Advisory Board, 2017

PUBLICATIONS:

I. Econometrics

- "Minimum Mean Square Estimators and Robust Regression," *Oxford Bulletin of Statistics*, April 1974.
- "Minimum Distance and Maximum Likelihood Estimation of Structural Models in Econometrics," delivered at the *European Econometric Congress, Grenoble: August 1974*.
- "Full-Information Instrumental Variable Estimation of Simultaneous Equation Models," *Annals of Economic and Social Measurement*, vol. 3, 641-652, October 1974.
- "Estimation and Inference in Nonlinear Structural Models," *Annals of Economic and Social Measurement*, 653-665, October 1975. (with E. Berndt, R.E. Hall, and B.H. Hall)
- "An Instrumental Variable Approach to Full-Information Estimators in Linear and Certain Nonlinear Econometric Models," *Econometrica*, Vol. 43(4), 727-738, 1975.
- "Simultaneous Equations with Errors in Variables," *Journal of Econometrics* 5, 1977.
- "Social Experimentation, Truncated Distributions, and Efficient Estimation," *Econometrica*, Vol. 45(4), 919-938, 1977. (with D. Wise)
- "A Conditional Probit Model for Qualitative Choice," with D. Wise, *Econometrica*, Vol. 46(2), 403-426, 1978.
- "Specification Tests in Econometrics," *Econometrica*, vol. 46(6), 1273-1291, 1978.
- "Non-Random Missing Data," with A.M. Spence, *MIT Working Paper* 200, May 1977.
- "Attrition Bias in Experimental and Panel Data: The Gary Income Maintenance Experiment," with D. Wise, *Econometrica*, vol. 47(2), 455-473, 1979.
- "Missing Data and Self Selection in Large Panels," *Annales de l'INSEE*, April 1978. (with Z. Griliches and B.H. Hall)
- "Stratification on Endogenous Variables and Estimation," in *The Analysis of Discrete Economic Data*, ed. C. Manski and D. McFadden, MIT Press, 1981. (with D. Wise)
- "Les models probit de choix qualitatifs," ("Alternative Conditional Probit Specifications for qualitative Choice.") (English Version), September 1977; EPRI report on discrete choice models, *Cahiers du Seminar d'Econometrie*, 1980.
- "The Econometrics of Labor Supply on Convex Budget Sets," *Economics Letters*, vol. 3(2), 171-174, 1979.

"Panel Data and Unobservable Individual Effects," *Econometrica*, vol. 49(6), 1377-1398, 1981. (with W. Taylor)

"Comparing Specification Tests and Classical Tests", (with W. Taylor) *Economics Letters*, 1981.

"The Effect of Time on Economic Experiments," invited paper at Fifth World Econometrics Conference, August 1980; in *Advances in Econometrics*, ed. W. Hildebrand, Cambridge University Press, 1982.

"Sample Design Considerations for the Vermont TOD Use Survey," with John Trimble, *Journal of Public Use Data*, 9, 1981.

"Specification and Estimation of Simultaneous Equation Models," in *Handbook of Econometrics*, ed. Z. Griliches and M. Intriligator, vol. 1, 1983.

"Identification in Simultaneous Equations Systems with Covariance Restrictions: An Instrumental Variables Interpretation," with W. Taylor, *Econometrica*, Vol. 51(5), 15-27-1549, 1983.

"Stochastic Problems in the Simulation of Labor Supply," in *Tax Simulation Models*, ed. M. Feldstein, University of Chicago Press, 1983.

"The Design and Analysis of Social and Economic Experiments," invited paper for 43rd International Statistical Institute Meeting, 1981; *Review of the ISI*.

"Full-Information Estimators," in Kotz-Johnson, *Encyclopedia of Statistical Science*, vol. 3, 1983

"Instrumental Variable Estimation," in Kotz-Johnson, *Encyclopedia of Statistical Science*, vol. 4, 1984

"Specification Tests for the Multinomial Logit Model," with D. McFadden, *Econometrica*, vol. 52(5), 1219-1240, 1984.

"Econometric Models for Count Data with an Application to the Patents R&D Relationship," *Econometrica*, vol. 52(4), 909-938, 1984.(with Z. Griliches and B. Hall)

"The Econometrics of Nonlinear Budget Sets," Fisher-Shultz lecture for the Econometric Society, Dublin: 1982; *Econometrica*, vol. 53(6) 1255-1282, 1985.

"The J-Test as a Hausman Specification Test," with H. Pesaran, *Economic Letters*, 1983.

"Seasonal Adjustment with Measurement Error Present," with M. Watson, *Journal of the American Statistical Association*, 1985.

"Efficient Estimation and Identification of Simultaneous Equation Models with Covariance Restrictions," with W. Newey and W. Taylor, *Econometrica*, 55, 1987.

"Technical Problems in Social Experimentation: Cost Versus Ease of Analysis," with D. Wise, in *Social Experimentation*, ed. J. Hausman and D. Wise, 1985.

"Errors in Variables in Panel Data," with Z. Griliches, *Journal of Econometrics*, 1986.

"Specifying and Testing Econometric Models for Rank-Ordered Data," with P. Ruud; *Journal of Econometrics*, vol. 34(1-2), 83-104, 1987.

"Semiparametric Identification and Estimation of Polynomial Errors in Variables Models," with W. Newey, J. Powell and H. Ichimura, *Journal of Econometrics*, 1991.

"Flexible Parametric Estimation of Duration and Competing Risk Models," with A. Han, *Journal of Applied Econometrics*, 1990.

"Consistent Estimation of Nonlinear Errors in Variables Models with Few Measurements," with W. Newey and J. Powell, 1987.

"Optimal Revision and Seasonal Adjustment of Updated Data: Application to Housing Starts," with M. Watson, Journal of the American Statistical Association Proceedings, 1991.

"Seasonal Adjustment of Trade Data," with R. Judson and M. Watson, ed. R. Baldwin, Behind the Numbers: U.S. Trade in the World Economy, 1992.

"Nonlinear Errors in Variables: Estimation of Some Engel Curves," Jacob Marschak Lecture of the Econometric Society, Canberra 1988, with J. Powell and W. Newey, Journal of Econometrics, vol. 65(1), 205-233. 1995.

"Nonparametric Estimation of Exact Consumers Surplus and Deadweight Loss," with W. Newey, Econometrica, vol. 63(6), 1445-1476, 1995.

"Misclassification of a Dependent Variable in Qualitative Response Models," with F. Scott-Morton and J. Abrevaya, Journal of Econometrics, 87, 239-269, 1998.

"Semiparametric Estimation in the Presence of Mismeasured Dependent Variables," with J. Abrevaya, Annales D'Economie et de Statistique, 55-56, 1999.

"A New Specification Test for the Validity of Instrumental Variables," Econometrica, vol. 70(1), 163-189. 2002. (with J. Hahn)

"Microeconometrics," Journal of Econometrics, vol. 100(1), 33-35. 2000.

"Long Difference Instrumental Variables Estimation for Dynamic Panel Models with Fixed Effects", with J. Hahn and G. Kuersteiner, mimeo May 2001, Journal of Econometrics, 140, 574-617, 2007.

"Mismeasured Variables in Econometric Analysis: Problems from the Right and Problems from the Left", Journal of Economic Perspectives Vol. 15(4), 57-67. 2001.

"Estimation with Weak Instruments: Accuracy of Higher Order Bias and MSE Approximations," with J. Hahn and G. Kuersteiner, Econometrics Journal vol. 7(1), 272-306. 2004. (Chosen as one of best papers in journal over the previous 10 years, 2008)

"Notes on Bias in Estimators for Simultaneous Equation Models", with J. Hahn, Economic Letters, 2002

"Triangular Structural Model Specification and Estimation with Application to Causality", Journal of Econometrics, Vol. 112(1), 107-113, 2003

"Weak Instruments: Diagnosis and Cures in Empirical Econometrics", with J. Hahn, American Economic Review, Vol. 93(2), 118-125, 2003.

"Instrumental Variable Estimation with Valid and Invalid Instruments", with J. Hahn, August 2003, Annales d'Economie et Statistique, No. 79-80, 2005.

"Difference in Difference Meets Generalized Least Squares: Higher Order Properties of Hypotheses Tests", with G. Kuersteiner, Journal of Econometrics, 144, 371-391, 2008.

"Response Error in a Transformation Model: Estimation of Wage Equations," with Jason Abrevaya, Econometrics Journal, Vol. 7(2), 366-388. 2004

"Asymptotic Properties of the Hahn-Hausman Test for Weak Instruments", with J. Stock and M. Yogo, Economic Letters, vol. 89(3), 333-342. 2005.

“Many Weak Instruments and Microeconomic Practice,” with C. Hansen and W. Newey, *Journal of Business and Economic Statistics*, 26, 398-422, 2008.

“A Semi-Parametric Duration Model with Heterogeneity that Does Not Need to be Estimated,” with T. Woutersen, Econometric Society World Meetings, London, 2005, *Journal of Econometrics*, 178, 2014, 114-131.

“Estimating the Derivative Function with Counterfactuals in Duration Models with Heterogeneity,” with T. Woutersen, *Econometrics Reviews*, 33, 2014, 472-496.

“Using a Laplace Approximation to Estimate the Random Coefficients Logit Model by Non-linear Last Squares”, with M. Harding, December 2005, *International Economic Review*, 2007.

“Duration Models,” *New Palgrave*, with T. Woutersen, March 2006.

“Hausman Tests”. *Encyclopedia of the Social Sciences*, 2nd ed., Woodbridge, CT: MacMillan Reference USA, (with H. White), (2007)

“IV estimation with Heteroskedasticity and Many Instruments,” with W. Newey T. Woutersen, J. Chao, and N. Swanson, March 2008, *Quantitative Economics*, 3, 2012..

“Testing for Causal Effects in a Generalized Regression Model with Endogenous Regressors,” with J. Abrevaya and S. Khan, March 2007, *Econometrica*, 2010.

“Properties of the CUE Estimator and a Modification with Moments,” with K. Menzel, R. Lewis, and W. Newey, September 2007, *Journal of Econometrics*, 165, 45-57, 2011

“Asymptotic Distribution of JIVE in a Heteroskedastic IV Regression with Many Instruments,” with J. Chao, W. Newey, N. Swanson, and T. Woutersen, May 2008, *Econometric Theory*, 2011

“A Bayesian Mixed Logit-Probit Model for Multinomial Choice,” with M. Burda & M. Harding *Journal of Econometrics*, 147, 232-246, 2008.

“A Poisson Mixture Model of Discrete Choice”, with M. Burda & M. Harding, October 2009, *Journal of Econometrics*. 166, 2012.

“Testing with Heteroskedasticity and Many Instruments”, with W. Newey T. Woutersen, J. Chao, and N. Swanson, *Journal of Econometrics*, 2014,.

“A Bayesian Competing Risk Model with Unobserved Heterogeneity”, with M. Burda & M. Harding,, June 2012, *Journal of Applied Econometrics*, 2015

“Hal White: Time at MIT and Early Days of Research”, in X. Chen and N. Swanson, eds., *Recent Advances and Future Directions in Causality, Prediction, and Specification Analysis: Essays in Honor of Halbert L. White Jr*, Springer 2012.

“Heteroskedasticity-Robust Inference in Finite Samples”, with C. Palmer, December 2011, *Economics Letters*, 116, 2012, 232-235

“Testing Overidentifying Restrictions using Many Moments”, with J. Chao, W. Newey N. Swanson, and T. Woutersen, *Journal of Econometrics*, 148, 2014, 15-21.

“An Expository Note on the Existence of Moments of Fuller and HFUL Estimators”, with J. Chao, W. Newey N. Swanson, and T. Woutersen, *Advances in Econometrics*, 29, “Essays in Honor of Jerry Hausman”, 2013

"Combining Two Consistent Estimators", with J. Chao, W. Newey N. Swanson, and T. Woutersen, Advances in Econometrics, 29, "Essays in Honor of Jerry Hausman", 2013

"The Genesis of the Hausman Specification Test", Advances in Econometrics, 29, "Essays in Honor of Jerry Hausman", 2013

"Individual Heterogeneity and Average Welfare", with W. Newey, July 2013, Econometrica, 2016

"Errors in the Dependent Variable of Quantile Regression Models", with Y. Leo and C. Palmer, April 2014

"Finite Sample Bias Corrected IV Estimation for Weak and Many Instruments", (with M. Harding and C. Palmer) Advances in Econometrics, 36, 2016, 245-273

"Nonparametric Welfare Analysis," (with W. Newey) Annual Review of Economics, 2016

"A New Sampling Algorithm for the Mixed Model of Multinomial Discrete Choice", (with M. Harding and Y. Xue), April 2016.

"Increasing the Power of Specification Tests", (with T. Woutersen), January 2017, forthcoming Journal of Econometrics

"An Econometric Life", January 2017, forthcoming Journal of Econometrics

"Estimating Dynamic Panel Models: Backing out the Nickell Bias", (with M. Pinkovskiy), November 2017, mimeo

"Specification Test on Mixed Logit Models", (with J. Hahn and J. Lustig), December 2017, mimeo

"Demand Estimation with Many Prices", (with V. Chernozukov and W. Newey), January 2018 mimeo

II. Public Finance and Regulation

"The Evaluation of Results from Truncated Samples," with D. Wise, Annals of Economic and Social Measurement, vol. 5, 421-446, April 1976.

"Discontinuous Budget Constraints and Estimation: The Demand for Housing," with D. Wise, Review of Economic Studies, vol. 7(146), 75-96. January 1980.

"The Effect of Taxation on Labor Supply: Evaluating the Gary Negative Income Tax Experiment," with G. Burtless, Journal of Political Economy, vol. 86(6), 1103-1130. 1978.

"AFDC Participation -- Permanent or Transitory?," in Papers from the European Econometrics Meetings, ed. E. Charatsis, North Holland: 1981.

"The Effect of Wages, Taxes, and Fixed Costs on Women's Labor Force Participation," Journal of Public Economics, vol. 14(2), 161-194. October 1980.

"The Effect of Taxes on Labor Supply," in How Taxes Affect Economic Behavior, ed. H. Aaron and J. Pechman, Brookings: 1981.

"Income and Payroll Tax Policy and Labor Supply," in The Supply Side Effects of Economic Policy, ed. G. Burtless, St. Louis: 1981.

"Individual Retirement Decisions Under an Employer-Provided Pension Plan and Social Security," with G. Burtless, Journal of Public Economics, 1982.

- "Individual Retirement and Savings Decisions," with P. Diamond, Journal of Public Economics, 1984.
- "Retirement and Unemployment Behavior of Older Men," in H. Aaron and G. Burtless, Retirement and Economic Behavior, Brookings: 1984.
- "Tax Policy and Unemployment Insurance Effects on Labor Supply," in Removing Obstacles to Economic Growth, ed. M. Wachter, 1984.
- "Family Labor Supply with Taxes," with P. Ruud, American Economic Review, 1984.
- "Social Security, Health Status and Retirement," with D. Wise, in Pensions, Labor, and Individual Choice, ed. D. Wise, 1985.
- "The Effect of Taxes on Labor Supply," in Handbook on Public Economics, ed. A. Auerbach and M. Feldstein, 1985.
- "Choice Under Uncertainty: The Decision to Apply for Disability Insurance," with J. Halpern, Journal of Public Economics, vol. 31(2) 131-161. 1986.
- "Household Behavior and the Tax Reform Act of 1986," with J. Poterba, Journal of Economic Perspectives, 1987, also published in French in Annales D'Economie et de Statistique, 1988.
- "Involuntary Early Retirement and Consumption," with L. Paquette, ed. G. Burtless, Economics of Health and Aging, 1987.
- "Income Taxation and Social Insurance in China," in Sino-U.S. Scholars on Hot Issues in China's Economy, 1990.
- "On Contingent Valuation Measurement of Nonuse Values," with P. Diamond, in Contingent Valuation: A Critical Appraisal, ed. J. Hausman, 1993.
- "Does Contingent Valuation Measure Preferences? Experimental Evidence," with P. Diamond, G. Leonard, M. Denning, in Contingent Valuation: A Critical Appraisal, ed. J. Hausman, 1993.
- "Contingent Valuation: Is Some Number Better than No Number?" with P. Diamond, December 1993, Journal of Economic Perspectives, 8(4), 45-64. 1994.
- "A Utility-Consistent Combined Discrete Choice and Count Data Model: Assessing Recreational Use Losses Due to Natural Resource Damage," with G. Leonard and D. McFadden, Journal of Public Economics, 56(1), 1-30. 1995.
- "Contingent Valuation Measurement of Nonuse Values," with P. Diamond, ed. R.B. Stewart, Natural Resource Damages: A Legal, Economic, and Policy Analysis, 1995.
- "A Cost of Regulation: Delay in the Introduction of New Telecommunications Services," with T. Tardiff, 1995, ed. A. Dumort and J. Dryden, The Economics of the Information Society, 1997.
- "Valuation and the Effect of Regulation on New Services in Telecommunications," Brookings Papers on Economic Activity: Microeconomics, 1997, 1-38.
- "Taxation by Telecommunications Regulation," Tax Policy and the Economy, 12(1), 29-48. 1998.
- "Taxation by Telecommunications Regulation: The Economics of the E-Rate", AEI Press, 1998.
- "Economic Welfare and Telecommunications Welfare: The E-Rate Policy for Universal Service Subsidies," with H. Shelanski, Yale Journal on Regulation, 16, 1999.
- "Efficiency Effects on the U.S. Economy from Wireless Taxation", National Tax Journal, 53, 733-742. September 2000.

“Residential Demand for Broadband Telecommunications and Consumer Access to Unaffiliated Internet Content Providers”, with H. Singer and J.G. Sidak, Yale Journal on Regulation, 18(1) 129-173, 2001.

“Regulating the U.S. Railroads: The Effects of Sunk Costs and Asymmetric Risk,” with S. Myers, Journal of Regulatory Economics, 22(3), 287-310. 2002.

“Regulated Costs and Prices in Telecommunications,” in G. Madden ed. International Handbook of Telecommunications, 2003.

Will New Regulation Derail the Railroads?, Competitive Enterprise Institute, October 2001

“Competition and Regulation for Internet-related Services”, in Korea Institute for Industrial Economics and Trade, Industrial Competitiveness and Competition Policy in the Era of Telecommunication Convergence. 2001. (also translated into Korean in a book)

“From 2G to 3G: Wireless Competition for Internet-Related Services,” presented at Brookings Conference, October 2001, R. Crandall and J. Alleman ed., Broadband, Brookings, 2002.

“Competition and Regulation for Internet-related Services: Results of Asymmetric Regulation”, presented at Columbia Univ. conference, October 2001, R. Crandall and J. Alleman ed., Broadband, Brookings, 2002

“United States: Lessons from the New Millennium,” with R. Crandall, in A. Brown et. al. eds., Telecommunications Reform in the Asia-Pacific Region, 2004

“Does Bell Company Entry into Long-Distance Telecommunications Benefit Consumers?,” with G. Leonard and J.G. Sidak, Antitrust Law Journal, 70(2), 463-484, 2002.

“Sources of Bias and Solutions to Bias in the CPI”, NBER Discussion paper 9298, Oct. 2002, Journal of Economic Perspectives, vol. 17(1), 23-44. 2003.

“CPI Bias from Supercenters: Does the BLS Know that Wal-Mart Exists?,” with E. Leibtag, presented at conference on Index Numbers, Vancouver, June 2004, NBER Discussion Paper w10712, August 2004. W.E Diewert, J.S. Greenlees, and C.R. Hulten eds., Price Index Concepts and Measurement, 2009.

“Did Mandatory Unbundling Achieve Its Purpose? Empirical Evidence from Five Countries,” with G. Sidak, Journal of Competitive Law and Economics, vol. 1(1), 173-245. 2005.

“Telecommunications Regulation: Current Approaches with the End in Sight,” (with G. Sidak) NBER conference on regulation, September 2005, in N. Rose. ed., Economic Regulation and Its Reform, 2014.

“Commentary on International Taxation: Tax Policy when Corporate Profits are a Return to Labor Rather than Capital,” with Roger Gordon, J. Mirrlees et. al., Dimensions of Tax Design, OUP, 2010.

“Wal-Mart Effects and CPI Construction”, in Price and Productivity Measurement, with E. Leibtag, W.E. Diewert, B.M. Balk, D. Fixler, K.J. Fox and A.O. Nakamura, editors, Trafford Press.

“Are Regulators Forward-Looking? Copper Prices and Telecommunications Networks,” with G. Sidak and T. Tardiff, FCC Communications Journal, 61, 199-227, 2008.

“Non-Neutrality of the Proposed RSPT”, Australian Economic Review, 44, 2011

“Telecommunications Deregulation”, with W. Taylor, American Economic Review, 2012

“Telecommunications in the US: From Regulation to Competition (Almost)”, with W. Taylor, Review of Industrial Organization, 42, 2013.

"Contingent Valuation: From Dubious to Hopeless", Journal of Economic Perspectives, 26, 2012.

"Partial Deregulation in Telecommunications: An Update", (with W. Taylor), 2016, Journal of Competition, Law, and Economics, 12, 2016, 465-476.

III. Applied Micro Models

"Project Independence Report: A Review of U.S. Energy Needs up to 1985," Bell Journal of Economics, vol. 6(2), 517-551. Autumn 1975.

"Individual Discount Rates and the Purchase and Utilization of Energy Using Durables," Bell Journal of Economics, vol. 10(1), 33-54. Spring 1979.

"Voluntary Participation in the Arizona Time of Day Electricity Experiment," with D. Aigner, in EPRI Report, Modeling and Analysis of Electricity Demand by Time of Day, 1979; Bell Journal of Economics, 1980.

"A Two-level Electricity Demand Model: Evaluation of the Connecticut Time-of-Day Pricing Test," in EPRI Report, Modeling and Analysis of Electricity Demand by Time of Day, 1979; Journal of Econometrics, vol. 10(3), 263-289. 1979.

"Assessing the Potential Demand for Electric Cars," with S. Beggs and S. Cardell, Journal of Econometrics, vol. 17(1) 1-19. 1981.

"Assessment and Validation of Energy Models," in Validation and Assessment of Energy Models, ed. S. Gass, Washington: Department of Commerce, 1981.

"Exact Consumer Surplus and Deadweight Loss," American Economic Review, 71(4)m 662-676, 1981.

"Appliance Purchase and Usage Adaptation to a Permanent Time of Day Electricity Rate Schedule," with J. Trimble, Journal of Econometrics, vol. 26(1-2), 115-139. 1984.

"Evaluating the Costs and Benefits of Appliance Efficiency Standards," with P. Joskow, American Economic Review, 72(2), 220-225. 1982.

"Information Costs, Competition and Collective Ratemaking in the Motor Carrier Industry," American University Law Review, 32 Am. U.L. Rev. 377 Winter 1983.

"An Overview of IFFS," in Intermediate Future Forecasting System, ed. S. Gass et al., Washington: 1983.

"Choice of Conservation Actions in the AHS," in Energy Simulation Models, ed. R. Crow, 1983.

"Patents and R&D: Searching for a Lag Structure," with B. Hall and Z. Griliches, in Actes du Colloque Econometrie de la Recherche, Paris: 1983.

"The Demand for Optional Local Measured Telephone Service," in H. Trebing ed., Adjusting to Regulatory, Pricing and Marketing Realities, East Lansing: 1983.

"Patents and R&D: Is There a Lag?," with B. Hall and Z. Griliches, 1985; International Economic Review, vol. 27(2), 265-283. 1986.

"Price Discrimination and Patent Policy," with J. MacKie-Mason, Rand Journal of Economics, vol. 19(2), 253-265. 1988.

"Residential End-Use Load Shape Estimation from Whole-House Metered Data," with I. Schick, P. Vsoro, and M. Ruane, IEEE Transactions on Power Systems, 1988.

- "Competition in Telecommunications for Large Users in New York," with H. Ware and T. Tardiff, Telecommunications in a Competitive Environment, 1989.
- "Innovation and International Trade Policy," with J. MacKie-Mason, Oxford Review of Economic Policy, 4, 1988, 56-72.
- "The Evolution of the Central Office Switch Industry," with W. E. Kohlberg, in ed. S. Bradley and J. Hausman, Future Competition in Telecommunications, 1989.
- "Future Competition in Telecommunications," 1987; ed. S. Bradley and J. Hausman, Future Competition in Telecommunications, 1989.
- "Joint Ventures, Strategic Alliances and Collaboration in Telecommunications," Regulation, 1991.
- "An Ordered Probit Model of Intra-day Securities Trading," with A. Lo and C. MacKinlay, Journal of Financial Economics, 1992.
- "A Proposed Method for Analyzing Competition Among Differentiated Products," with G. Leonard and J.D. Zona, Antitrust Law Journal, 60, 1992.
- "Global Competition and Telecommunications," in Bradley, et al., ed., Globalization, Technology and Competition, 1993.
- "The Bell Operating Companies and AT&T Venture Abroad and British Telecom and Others Come to the US," in Bradley, et al., ed., Globalization, Technology and Competition, 1993.
- "The Effects of the Breakup of AT&T on Telephone Penetration in the US," with T. Tardiff and A. Belinfante, American Economic Review, vol 63(2), 178-184. 1993.
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EXHIBIT 2

Exhibit 2: Pre-judgment Interest on Jury Award

Period	[A] Prime Rate	[B] Starting Balance	[C] Interest	[D] Royalty	[E] Ending Balance
Mar10-May10	3.25%	0	\$0	\$2,450,495	\$2,450,495
Jun10-Aug10	3.25%	\$2,450,495	\$19,910	\$2,450,495	\$4,920,900
Sep10-Nov10	3.25%	\$4,920,900	\$39,982	\$2,450,495	\$7,411,378
Dec10-Feb11	3.25%	\$7,411,378	\$60,217	\$2,450,495	\$9,922,090
Mar11-May11	3.25%	\$9,922,090	\$80,617	\$2,450,495	\$12,453,202
Jun11-Aug11	3.25%	\$12,453,202	\$101,182	\$2,450,495	\$15,004,880
Sep11-Nov11	3.25%	\$15,004,880	\$121,915	\$2,450,495	\$17,577,289
Dec11-Feb12	3.25%	\$17,577,289	\$142,815	\$2,450,495	\$20,170,600
Mar12-May12	3.25%	\$20,170,600	\$163,886	\$2,450,495	\$22,784,981
Jun12-Aug12	3.25%	\$22,784,981	\$185,128	\$2,450,495	\$25,420,604
Sep12-Nov12	3.25%	\$25,420,604	\$206,542	\$2,450,495	\$28,077,641
Dec12-Feb13	3.25%	\$28,077,641	\$228,131	\$2,450,495	\$30,756,267
Mar13-May13	3.25%	\$30,756,267	\$249,895	\$2,450,495	\$33,456,657
Jun13-Aug13	3.25%	\$33,456,657	\$271,835	\$2,450,495	\$36,178,987
Sep13-Nov13	3.25%	\$36,178,987	\$293,954	\$2,450,495	\$38,923,437
Dec13-Feb14	3.25%	\$38,923,437	\$316,253	\$2,450,495	\$41,690,185
Mar14-May14	3.25%	\$41,690,185	\$338,733	\$2,450,495	\$44,479,413
Jun14-Aug14	3.25%	\$44,479,413	\$361,395	\$2,450,495	\$47,291,303
Sep14-Nov14	3.25%	\$47,291,303	\$384,242	\$2,450,495	\$50,126,040
Dec14-Feb15	3.25%	\$50,126,040	\$407,274	\$2,450,495	\$52,983,809
Mar15-May15	3.25%	\$52,983,809	\$430,493	\$2,450,495	\$55,864,797
Jun15-Aug15	3.25%	\$55,864,797	\$453,901	\$2,450,495	\$58,769,194
Sep15-Nov15	3.25%	\$58,769,194	\$477,500	\$2,450,495	\$61,697,189
Dec15-Feb16	3.46%	\$61,697,189	\$533,167	\$2,450,495	\$64,680,850
Mar16-May16	3.50%	\$64,680,850	\$565,957	\$2,450,495	\$67,697,303
Jun16-Aug16	3.50%	\$67,697,303	\$592,351	\$2,450,495	\$70,740,149
Sep16-Nov16	3.50%	\$70,740,149	\$618,976	\$2,450,495	\$73,809,620
Dec16-Feb17	3.71%	\$73,809,620	\$685,199	\$2,450,495	\$76,945,315
Mar17-May17	3.96%	\$76,945,315	\$761,759	\$2,450,495	\$80,157,569
Jun17-Aug17	4.21%	\$80,157,569	\$843,658	\$2,450,495	\$83,451,722
Sep17-Nov17	4.25%	\$83,451,722	\$886,675	\$2,450,495	\$86,788,892
Dec17-Feb18	4.47%	\$86,788,892	\$969,143	\$2,450,495	\$90,208,529
Mar18-May18	4.69%	\$90,208,529	\$1,058,447	\$2,450,495	\$93,717,471
Jun18-Jul18	4.95%	\$93,717,471	\$772,388	\$1,633,663	\$96,123,523
Total			\$13,623,523	\$82,500,000	

Notes and Sources:

Royalty assumed to be received at end of each period

[A]: Bank Prime Loan Rate (<https://fred.stlouisfed.org/series/MPRIME>), average of monthly values

[B] = [E] for previous period

[C] = [B]*[A]/4 (multiplied by 2/3 for Jun18-Jul18 period)

[D] = 3*\$82.5 million/101 (multiplied by 2/3 for Jun18-Jul18 period)

[E] = [B]+[C]+[D]

EXHIBIT 3

Exhibit 3: Post-judgment Interest

Panel A: Interest on Jury Award

	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year
[A] Principal	\$82,500,000	\$84,513,000	\$86,575,117	\$88,687,550	\$90,851,526	\$93,068,304	\$95,339,170	\$97,665,446	\$100,048,483	\$102,489,666
[B] Interest rate	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%
[C] Interest (annual)	\$2,013,000	\$2,062,117	\$2,112,433	\$2,163,976	\$2,216,777	\$2,270,867	\$2,326,276	\$2,383,037	\$2,441,183	\$2,500,748
[D] Interest (daily)	\$5,515	\$5,650	\$5,787	\$5,929	\$6,073	\$6,222	\$6,373	\$6,529	\$6,688	\$6,851

Panel B: Interest on Jury Award and Pre-judgment Interest

	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year
[A] Principal	\$96,123,523	\$98,468,936	\$100,871,579	\$103,332,845	\$105,854,166	\$108,437,008	\$111,082,871	\$113,793,293	\$116,569,850	\$119,414,154
[B] Interest rate	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%	2.44%
[C] Interest (annual)	\$2,345,414	\$2,402,642	\$2,461,267	\$2,521,321	\$2,582,842	\$2,645,863	\$2,710,422	\$2,776,556	\$2,844,304	\$2,913,705
[D] Interest (daily)	\$6,426	\$6,583	\$6,743	\$6,908	\$7,076	\$7,249	\$7,426	\$7,607	\$7,793	\$7,983

Notes and Sources:

- [A] Panel A: starts at jury award
Panel B: starts at jury award plus pre-judgment interest (Exhibit 2)
Interest added to principal each year
- [B] 1-Year Treasury Constant Maturity Rate for week ending August 3, 2018 (<https://fred.stlouisfed.org/series/WGS1YR>)
- [C] = [A]*[B]
- [D] = [C]/365

EXHIBIT 4

Exhibit 4: Ongoing Monthly Royalty

		'849 Patent	'346 Patent
[A]	Hausman royalty	\$166,468,823	\$59,166,569 \$43,064,289
[B]	Jury award	\$82,500,000	
[C]	Ratio	49.6%	
[D]	Scaled Hausman royalty	\$29,322,259	\$21,342,158
[E]	Number of months in past royalty period	101	85
[F]	Monthly royalty	\$290,319	\$251,084
[G]	Number of months in future royalty period	59	120
[H]	Post-judgment royalty	\$47,258,949	\$17,128,844 \$30,130,105

Notes and Sources:

[C] = [B]/[A]

[D] = [A]*[C]

[E] '849: Number of months from March 2010 through July 2018; '346: Number of months from July 2011 through July 2018

[F] = [D]/[E]

[G] '849: Number of months from August 2018 through June 2023; '346: Number of months from August 2018 through July 2028

[H] = [F]*[G]